A STUDY OF THE ANGLE OF SPREAD OF THE DOWNCOMING RADIO-WAVES

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ABSTRACT. The angle of spread has been measured for the vertical-incidence pulsed radio-waves returned from both the *E*-and the *F*- regions of the ionosphere on two undisturbed days. Observations cover all the hours of the day and night.

In the case of the *E*- region returns, the value of the angle of spread is found to occur between 50′ and 7° with an average value of 4° 20′. The most preferred range of this angle is found to be 4° to 5°.

In the case of the *F*- region returns, the value of the angle of spread is found to occur between 30′ and 10° with an average value of 4° 50′. The most preferred range of this angle is again found to be 4° to 5°.

INTRODUCTION

From the findings of Ratcliffe *et al.* (1933) and Pawsey (1935), Ratcliffe (1948) concluded that radio waves are returned by a process of diffractive reflection from the ionospheric irregularities. On account of the presence of these irregularities which act as scattering centres, there is a cone of radio waves scattered to the receiving point. The fading of a singly-reflected wave can then be attributed to the changing interference conditions between the various elementary wavelets scattered from the different scattering centres within the cone. The semiangle of this cone is called the angle of spread of the scattered components.

A method of determination of the angle of spread was described by Briggs *et al* (1950). Later Briggs (1951) described another much simpler but slightly approximate method for the determination of the angle of spread. Assuming the horizontal movement of the ionospheric irregularities to be the main cause of fading, he deduced the relation

$$N = \frac{2V}{\lambda} \sin \theta$$

where N = number of maxima of the fading pattern per second.

V = horizontal drift velocity of the ionospheric irregularities.

λ = wave-length of the sounding radio-wave.

and θ = angle of spread.

The above relation has been used in the present investigations to measure the angle of spread.

EXPERIMENTAL DETAILS

The records were taken at Waltair (Geographic Lat. 17° 43′ N; long. 83° 18′ E; Geomag. lat. 7.4°N) with the vertical-incidence pulsed radio-waves by the three spaced-receivers technique of Mitra (1949). The transmitting antenna was of multiple-wire delta-type and the receiving antennas were three tuned dipoles fixed parallel to one another at the three corners of a right angled isoceles triangle. The two equal sides of the triangle were each of 108 meters and were oriented along the East-West and North-South directions. Each record was of 4 to 6 minutes duration. A typical record is shown in Fig. 1.

The horizontal drift velocity, V, of the ionospheric layer was determined using all the three fading curves by the similar fade method of Mitra (1949), and the number of maxima of the fading pattern per second, N was obtained using only the central fading curve.

The records on the days of magnetic disturbance or solar flare were rejected. The angle of spread of the downcoming radio waves was determined with fifty records in all. Twenty five of these were due to the F-region returns and were taken on 15th December 1959. The remaining twenty five were due to the E-region returns and were taken on 17th December 1959. On these two days no solar flare was recorded at Kodaikanal (lat. 10° 14′N, long. 77° 29′E. Geomag. lat. 00° 44′ N) and no magnetic disturbance was recorded at Alibag (lat. 18° 38′N long. 72° 52′ E, Mag. Lat. 9°N)*. The International Magnetic Character figures for 15th December and 17th December 1959 are respectively 1 and 0. The records of both the days cover all the hours of the day and night.

For the E-region returns the operating frequency was 2.5 Mc/s and for the F-region returns the operating frequency was 5.6 Mc/s during the day-light hours and 2.5 Mc/s during the night hours. The records in the night hours of E-region are due to reflection from sporadic E-layer. The reflection height for E-region was between 100 to 120 km. and that for F-region between 255 to 315 km.

EXPERIMENTAL RESULTS

In the case of the E-region returns, the values of the angle of spread have been found to occur between 50′ and 7° with an average value of 4° 20′. In the case of the F-region returns, the values have been found to be between 30′ and 10°, with an average of 4° 50′.

From the histograms (Fig. 2) it is observed that the most preferred range of the angle of spread for the returns from both the regions is 4° to 5°. In the case of the E-region returns the angle of spread does not go beyond 7°, but in the case

*The geomagnetic latitudes of Waltair and Alibag are very nearly the same.

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